1990. Vertebrate Pest Management, a Training Manual, Joe E. Brooks, Ejaz Ahmad, Iftikhar Hussain, Shahid Munir and A. Aziz Khan, editors, pgs. 165-171.

PRINCIPLES OF ORNITHOLOGY

By Joe E. Brooks and Iftikhar Hussain

A. Characteristics of Birds

Birds are unique animals, adapted to a wide range of habitats while retaining basic characteristics which make them recognized as "birds". Like mammals, they are warm-blooded.

1. External Features

Birds are the only animals to possess feathers. Feathers are derived from the epidermal scales of reptilian ancestors and have adapted to a variety of functions: flight, insulation, display, camouflage, water-repelling, insect-catching, etc.

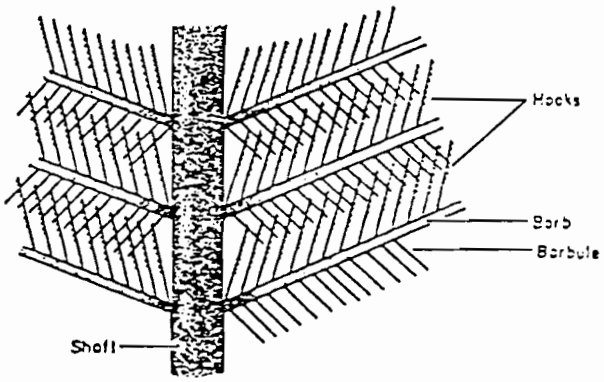

Fig. 1. A close-up look at a feather.

The structure of the feather is very simple. A feather consists of a main shaft from which the barbs arise (these make up the vane of the feather). From each barb there arises barbules, both forward and backward (Fig. 1). Each barbule has a series of hooklets which attach onto the flanged edge of the barbules on the next adjacent barb. The barbules, with their hooks, act much like zippers. This mechanism gives the bird a structure which affords lightness (the shaft is hollow), flexibility and air-worthiness.

The birds' body has been streamlined so it is aerodynamically efficient. This is done by the feathers overlapping and smoothing the angular air-resistant surfaces. The feet also can be withdrawn into "bays" when in flight.

2. Internal Features

Birds achieve lightness internally also. They have lost their teeth and the heavy jaws needed to support them. Instead, birds have a beak which is composed of bone overlain with horny keratin. The beak is hollow and the whole head is relatively lightweight. The skeleton has been reduced by a hollowing, thinning, and flattening of the remaining bones. The intestine has been radically shortened and the urinary bladder has been eliminated. There are air spaces in the bones, body cavity, and elsewhere.

Since birds have no teeth, the digestive system must accommodate with a grinding mechanism. Food swallowed whole is stored in the elastic crop and released into the muscular gizzard, which performs the same function as human teeth and stomach combined. Birds swallow small stones so there will be some abrasive material in the gizzard.

The body has been balanced by positioning all locomotor muscles toward the bird's center of gravity-leaving the wings to be controlled by tendon-like strings. Wings and legs contain relatively little muscle. Body organs are gathered in a mass in the center of the body.

Birds have large eyes and a wide visual field with remarkable distance determination, and by a brain with greatly enlarged visual and locomotor centers. This gives birds excellent visual acuity and rapid control of muscular reactions.

Breathing in birds is accomplished in flight and at rest by the contraction movements of the pectoral muscles. There is no diaphragm muscle as in mammals. The lungs of birds are very dense and relatively small; extensions of lung tissue permeate long bones and some body cavities. These air sacs add to buoyancy and also help regulate body temperature.

B. Classification of Birds

Birds are classified on the basis of the possession of certain external and internal features. The Class Aves (birds) includes all those warm-blooded animals with a four-chambered heart which have an external covering of feathers. Other features of the class include a hollow bony beak with horny covering, scaled legs with (usually) four functional toes with claws.

There are presently accepted 27 orders of birds. Those orders most important in vertebrate pest management in Pakistan are:

Columbiformes:	pigeon-like birds
Psittaciformes:	parrot-like birds
Passeriformes:	perching birds (this order includes many of the pest species, such as sparrows, larks, bulbuls, finches, mynas, weavers, starlings and crows).

We are interested in two other orders of raptorial and scavenging birds because they may become secondarily poisoned by eating rodents or other animals that have fed upon toxic pesticides. These are:

Strigiformes:	owls
Falconiformes:	vultures, eagles, kites and hawks.

C. Reproduction and Development

1. Mating and Nesting

Mating varies from promiscuous copulation and little parental care to high degrees of parental care and of individual birds paired for life.

At one end of a continuum are some kinds of fowl which bury their eggs in places like compost heaps, which heat up and incubates the eggs. The young, upon hatching, are precocial and able to gather food for themselves. Other birds mate together for periods of several years or for life, even though they may not remain together during the non-mating period. They return to the same breeding areas each year, mate and build the nest together. After the eggs hatch, the young are cared for by the parents until ready to fly.

Nests vary from simple depressions in soil or gravel to elaborately woven structures swinging from tree branches. Woven nests may be solitary or communal. Weaver birds commonly make their nests together, with many hanging from one tree.

Nest building is a stereotyped behavior of birds. Materials gathered are usually typical and specific for each bird species. Also the placement of the nest is species-specific. Some may nest in crotches in trees, some in grassy depressions on the ground, while others prefer cavities in trees or holes in cliff banks.

2. Eggs, Egg-Laying and Incubation

Eggs are laid in the nest, usually one at a time, one each day for several days, until the number of eggs for the particular species is reached. This number of eggs is known as the clutch size for that species. If one egg is removed daily by a human observer before the optimum number is reached, the female will continue to lay one egg each day for many more days before quitting.

Birds eggs are unique structures. They are incubated by the heat of the parent birds, except for a few gallinaceous birds. The germ cell is suspended upon the yolk and enclosed in albumin. The yolk is suspended by white chalazae, which are ribbons anchored in the egg white. Chalazae keep the germ cell upright even when eggs are turned, nearest to the body heat of the incubating parents (Fig. 2).

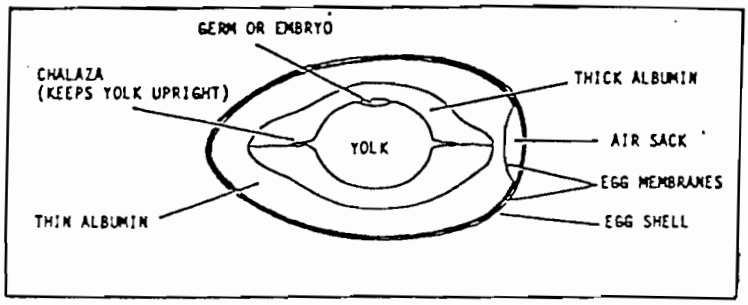

Fig. 2. A bird egg.

Incubation is accomplished when eggs are in contact with bare skin of the parent birds. Bare skin is produced either by plucking the feathers from the brood area or by the ruffling of the feathers away from the brood area. Generally the lower breast area becomes reddened and infused with blood so that the temperature approximates the parents' body temperature (often 100 degrees F. or more). Brood patches are pressed directly against the egg shell surface. Incubation time is highly variable and even varies within a species when there are environmental changes. Generally in passerine birds it averages about 12 days; larger birds have been known to incubate up to 80 days. As a rule, birds which hatch fully developed (precocial) young have longer incubation times; those which are altricial (hatch bare-skinned and eyes closed) and rely on the parents hatch sooner, but must depend on the parents for an additional time period - a week or two.

3. Parental Care

Parental care consists of feeding, warming, protecting, cleaning, and instructing the young. Parents feed the young with a variety of materials. Passerines often collect high protein insect larvae, which they feed whole to the nestlings. Other parent birds permit the young to have access to their crop, where the young may get partly digested food.

Altricial young are brooded beneath the parent birds when nights are cool. Since their feathers are not fully developed and they have not developed the ability to regulate their own body temperatures, this is essential. Precocial young are also brooded, probably more for protection than for warming.

Protection of young may take several forms. Males may exclude other species besides their own from their territories by aggressive actions. Other species may defend only the immediate nest. Protection may be direct, such as attack with beak or claws or the defecating by gulls on humans when nearing a nest. It may be indirect as when a mother plover feigns injury of the wing to lure potential predators away from the nest area.

D. Behavior

1. Migration

Migration is the regular, cyclic or seasonal movements of large number of birds from a breeding ground to a wintering ground or vice versa. While we understand some of the reasons why birds migrate, there are still many reasons for migratory behavior that we do not know.

In general, migration occurs along a north-south axis. This is especially true in the Western Hemisphere. In the Old World, however, there are more examples of southerly movements by way of eastward or westward pathways. It is thought that birds travel such zig-zag routes to avoid crossing large bodies of water (Mediterranean Sea), or deserts (Sahara) or mountains (Himalayas). In contrast, many of the migrants moving between North and South America have only to cross the Gulf of Mexico and the Caribbean.

Migration patterns vary. Some species move in large homogeneous flocks; others in highly organized flight patterns (geese). Still others move in along a broad front.

Movement of birds appears primarily related to day length (photoperiod). The lengthening days in late winter stimulates the sex glands. This brings on a restlessness and the birds begin more feeding to increase their body weight. Northward migration is coordinated with movement of weather frontal systems. In spring, birds await low pressure systems which bring southerly warm fronts. Migratory flights proceed most rapidly behind an advancing warm front.

In autumn, the sex glands have grown smaller, decreasing the territorial distance individual birds maintain toward each other. This permits flocking species to become integrated into organized flocks. As polar air masses come southward and cold air fronts precede low pressure systems, birds fly off in a southerly direction.

There is general agreement that migratory birds have the ability to orient using a compass. The more familiar orientational cues used by birds for simple compasses are the sun, the stars and the earth's magnetic field. The position of the sun in relation to the birds' biological clock (circadian rhythm) provides compass information and the position of the setting sun can be used by nocturnal migrants as a compass at about the time they begin their nightly flights. There is abundant evidence that the stars function as a simple compass for birds. Time compensation is not required because the star patterns can provide directional information. For example, Polaris, the North Star, is always to the north in the northern hemisphere. Finally there is increasing evidence that birds can detect the earth's magnetic field and use it to direct themselves along a north-south axis.

2. Territory

Any area defended by a bird against individuals of its own species is *territory*. Most bird species show at least some type of territorialism. Territory is roughly classified into *breeding territory* and *nonbreeding territory*. Breeding territory is used for the mating, nesting and feeding area for the young birds and their parents. This is the commonest type. Some species have only a mating and nesting (but not feeding) area. Others use a mating area only, maintained apart from the nest.

Nonbreeding territories are oftentimes feeding areas outside the breeding territory but which nevertheless are defended. Some areas may be defended in the winter months, particularly by permanent-resident birds that may or may not use the same territories during the breeding season. Some other species have roosting areas, specific sites used for night roosting. Some bird species will defend such areas.

Male birds usually establish the breeding territory, advertise this to other birds of the same species and defend it against males of its own species. Females may or may not participate in defense of the breeding territory. Methods used to establish and defend territories involve agonistic behaviors - threat displays, physical encounters, appeasement displays, pursuit-flying and singing or other vocalizations.

E. Bird Populations and Their Regulation

1. Longevity

Birds have a capacity for longevity in captivity of around 20 to 30 years. But it is not common for birds in the wild to live to this age. Birds are subject to a great variety of environmental factors which shorten life span: diseases, parasites, predation, unfavorable weather, competition, and accidents, etc. As a rule, the larger the bird, the longer it is likely to live.

2. Bird Numbers

How many birds are there? Nobody knows with any certainty. One expert placed the numbers at 100 billion but it could be higher. Only two countries have tried to count their bird numbers. In Great Britain, from bird censuses in selected habitats, the number of breeding land birds totalled 120 million. In Finland, the total number of birds was estimated to be 64 million.

Probably the domestic fowl (chicken) is the most numerous bird in the world, and it has been suggested that the house sparrow and the European starling may be as numerous.

3. Bird Populations

A population is the total number of individuals in an area. Although the term is usually applied to a single species, it is commonly used to cover all the species in an area. Since interactions between bird species sharing a tract of habitat are close and complex, studies of birds often focus on the entire bird community as a unit. Bird communities vary both in composition and size, and population studies cover both the diversity and abundance aspects of their structure.

Studies of bird populations are required in vertebrate pest management. Control of pest species such as house sparrows, European starlings, rose-ringed parakeets, and occasionally other species requires information on densities, feeding strategies, flocking behavior, and appropriate management procedures.

The size and structure of a bird community depends upon the environmental conditions in the area, the climate and particularly the nature and richness of the local food and habitat resources. These factors change from place to place and from season to season. Bird communities typically are dynamic, changing as the environmental conditions change.

4. Population Regulation

Although they are sensitive to fluctuation in weather and other irregular and erratic variables, bird populations in stable environments rarely deviate appreciably from the local "norm" and tend to return quickly to that norm after a disturbance.

Agro-ecosystems, however, are not stable habitats in the classical sense. They are highly unstable and changing rapidly from growing season to growing season. Here bird populations may undergo striking changes in both numbers and composition of species.

Factors that control and regulate bird populations in the wild can be divided roughly into two categories: *density- independent factors* (such as weather, natural catastrophes, habitat alterations and man-induced disturbances) and *density- dependent factors* (those factors that intensify their effects when population densities are high and relaxing when densities are low). Density-dependent factors include food availability, nest site availability, territories available for use, predation, diseases and parasites. In general, density-independent factors are those that comprise the physical aspects of the environment while density-dependent factors are the biological aspects.

The population level attained and maintained by a species or a group of species is thought of as the resource level of the local environment - i.e., its carrying capacity. To meet the requirements of this system, i.e. to fully replace themselves in the next generation - breeding adults must lay more eggs than can be expected to survive as breeding adults. The margin between number of eggs laid and number of breeding adults is generally large.

It is generally accepted that a female bird will lay as many eggs as she and her mate can raise to independence under the local circumstances. This reproductive potential is in rough balance with the mortality rate of that species.

The mortality rate of young among nidifugous birds (those that leave the nest soon after hatching) is about 75 percent, which is not surprising when one considers the hazards that chicks are subjected to during the long period between hatching and fledging.

The mortality rate of young among altricial species is much lower - roughly 45 percent - because the period between hatching and fledging is spent as nestlings with greater protection.

F. Birds as Pests

A listing of damage caused by birds would include damage to crops, buildings, livestock and ornamental plants. Some have been responsible for contamination of food and other commodities stored in warehouses. In recent years rapid jet aircraft have collided with birds in flight and some have crashed with loss of human life. The solution to this problem is not fully known.

Simple or simplistic solutions to pest bird problems are often proposed. Damage control through exclusion is often advised, as for example to prevent fecal contamination to stored commodities. Sometimes this may be impossible, as for exclusion of birds from hundreds of acres of croplands.

Lethal control, direct killing of birds, has been shown to have little long-term effect. Lethal control against a species with high reproductive potential is biologically unsound because populations will breed and return to their former numbers quickly.

It is the job of vertebrate pest management specialists primarily to carry out damage control measures. When direct control measures are to be taken against a bird species, it is essential that the population of birds be considered, and the potential impact of the control measures carefully weighed.

This caution is made because there may be two very different situations in which birds cause damage. One could say that there are (1) pest birds, and (2) birds which become pests sometimes by being in the wrong place. A definition of "pest" will make this clear. Pests have these qualities:

1. A high tolerance for and adaptability to external changes. They are not highly sensitive to minor changes in weather, food supply, available nesting sites, etc. They are flexible.

2. Low requirements for living. They can survive on minimum food of rather low quality. Their diet can vary as to what is available. Their needs are simple.

3. The ability to reproduce large numbers of offspring after the population has been drastically reduced. Recovery periods of some species can be long after drastic reduction. Not so with a pest species. Drastic reduction simply makes breeding conditions better for survivors, and they reproduce quickly.

Note that not all birds fit these definitions. A non-pest bird species can create problems for humans by:

1. Disease transmission
2. Crop damage
3. Aircraft-bird strikes
4. Other incidents where a bird population may be in the wrong place and cause some damage.

Clearly "pest populations" of the first two types must be dealt with differently.

This definition of a pest species suggests that it is not easy to classify a bird as a pest or nonpest without detailed studies on the life history, biology, ecology, behavior and population dynamics. Ideally, all these studies should be brought together before bird control programs are undertaken. In practice, this is rarely done. Too often, the solution, temporary at best, is to kill the offending birds. While this approach is politically expedient, it is not biologically sound.

Greater success will come from population management methods that rely on habitat management to decrease the carrying capacity of the environment. Alteration of cropping patterns, planting dates, etc., may give some relief, but will require re-education of the public (farmers) and changes in attitudes. Often, the crux of the bird problem is a people problem. Some fault or mistake or habit of humans often causes bird damage.